Brilliant Force and the Expert Architecture that Supports It

A Research Paper
Presented To

Air Force ***2025***

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August 1996

New Text Document.txt

26 NOVEMBER 1997

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Executive Summary

This paper demonstrates that a new military education and training architecture, supported by investments in key technology components, will produce a brilliant force to meet the challenges of 2025.

Several drivers will shape the 2025 environment and foster assumptions from which derive the required capabilities for education and training in 2025 (ET2025). Our engagement in non-traditional missions will increase. Military operations will be highly complex and joint as well as combined. The demand for highly trained people will intensify. The pace of technological progress will increase. Thus, we must produce "brilliant warriors." To do so, the military must provide continuous (career-long), on-demand learning tailored to the individual, incorporating technologies that optimize the learning environment. This "agile" education and training system will be capable of rapidly changing in concert with the external environment.

The functions and processes of ET2025 will closely resemble today's system in that air and space forces must still be concerned with the transfer of knowledge, skills, and wisdom from one source to another. What will be different are the methods and architecture used to accomplish that transfer. Although most of the examples in this paper deal with training, the architecture will support either training or education. Education and training will be available to anyone, anytime, anywhere by way of a new architecture consisting of the national knowledge superhighway, academic centers of excellence for curriculum development, and expert tutors (EXTOR)—all personal artificial intelligence agents. The technologies the military must leverage to enable agile learning are artificial intelligence, virtual reality (and its improvements to simulation), and

improvements in computing and communications. In addition, advances in hyperlearning—expanded use of emerging technologies to create a "whole-brain" learning environment—will create air- and spacepower experts in the shortest possible time and at the lowest possible cost. Enhanced screening tools will further reduce costs by training the right people for the right job.

Together, these concepts form the basis for a new education and training architecture: highly efficient and effective education and training, individualized, on demand and just in time—a paradigm to meet the challenge and produce the brilliant force of 2025.

Chapter 1

Introduction

Remember Mr Spock from *Star Trek* and his "Vulcan mind meld"? By placing his fingertips on another person's cranium, Spock could effect the transfer of images, knowledge, data, and memories from his brain to theirs, or vice versa. The transfer was quick, cheap, tailored (Spock could extract only the information he wanted), and permanent, all characteristics which the air and space forces of 2025 could use to measure the efficacy of their own training and education programs. If we look at education and training, at its simplest, as being the transfer of knowledge or skills from one person or source to another, Spock's Vulcan mind meld could become the paradigm for education and training in 2025, hence ET2025.

Education and training *aren't* simple, however, and the mind meld won't serve as the cornerstone of the ET2025 architecture for several reasons: its technologically infeasible, manpower-intensive, and requires the collocation of "teacher" and "student." Recognizing these inadequacies, though, helps us frame criteria which will support a stronger education and training architecture in the future, regardless of the stresses confronting our forces.

Although air and space missions, structures, and technologies may have changed by 2025, education and training still will be an important (perhaps *more* important) element of successful mission accomplishment. Further, the fundamental interaction of education and training—the

transfer or development of knowledge or skills—will not change. What *will* change, and what we intend to explore in this paper, are the selection processes for identifying personnel for specific education and training programs, the process by which the transfer of knowledge or skills takes place, and the means of evaluating the end result.

The final evaluation of ET2025 will occur on future battlefields. Success in future operations will demand military professionals intellectually and technically prepared to dominate our adversaries across the full continuum of competition. While technology will provide the tools to engage and defeat our adversaries, education will leverage the most powerful factor in the war-winning equation—the human mind. And training will enable military professionals to use those tools to best advantage.[1]

Understanding the process by which we establish this foundation for battlespace dominance requires a definition of the terms. *Education* develops the intellectual capital required for success and prepares us for future success on many fronts. It develops intellectual constructs that enable visionary military leaders to develop the tools essential to future victory and the ability to use them to achieve their desired effect. It also prepares future leaders to respond quickly, accurately, and decisively to unanticipated and ambiguous situations. By at least one definition, the true test of education is success in environments not fully understood or existing today.[2]

If the test of education is success in environments not existing or understood today, the test of training is competence in environments that do exist and are understood today.[3] *Training* develops the physical as well as mental capital—the technical skills of our warriors—necessary to execute highly complex, technically challenging military tasks in the face of a hostile

adversary. It creates competence in using the tools required for military tasks and produces the capability to perform specific military tasks effectively and efficiently.

While education and training differ in outcomes, the process by which we do both, and the tools we use are similar, if not the same. Thus, when referring to the process of training and/or educating, we will use the abbreviation TRED throughout this paper. We look at TRED, at its simplest, as being the transfer of knowledge or skills from one person/source to another. If specifying a particular outcome (knowledge or skills), we will use the terms *education* or *training*, respectively, as defined above.

The year 2025 will resemble 1996 in at least one respect: the outcome of military operations will reflect the education and training of the participants. However, the TRED process *must,* and *will*, be remarkably different. If our nation expects its military forces to wage war successfully in 2025 and to anticipate the requirements for waging war in 2050, we must revolutionize our TRED process. This process—ET2025—must be revolutionary and will have but a single purpose—creating the "brilliant force" capable of dominating the battlespace of 2025.

Notes

[1] Lt Gen Jay W. Kelley, "Brilliant Warrior" (Unpublished article, Maxwell AFB, Ala.: Air University, 1996), 1.

[2] Ibid., 2.

[3] Ibid.

Chapter 2

Required Capability

Articulating a coherent vision for 2025 TRED requires a framework for analyzing 2025's TRED imperatives. This paradigm logically will reflect processes for educating and training—or transferring knowledge and skill—and will provide a framework from which we can make useful observations. It will illuminate critical processes internal to the broader "education and training" process, as well as external systems that impact the efficacy of TRED programs. Finally, it must reflect what we know and what is prudent to assume about the future as it will be in 2025. The models that demonstrate the critical processes, together with the drivers that will to help define the environment in which it must operate, will illuminate the imperatives for ET2025.

Models

We use the instructional system development (ISD) and life-cycle models to illustrate the significance of education and training for 2025.

Instructional System Development

The ISD Model represents the process involved in the actual conduct of education and training: it is likely the most popular instructional design model in use today (fig. 2-1).[1]

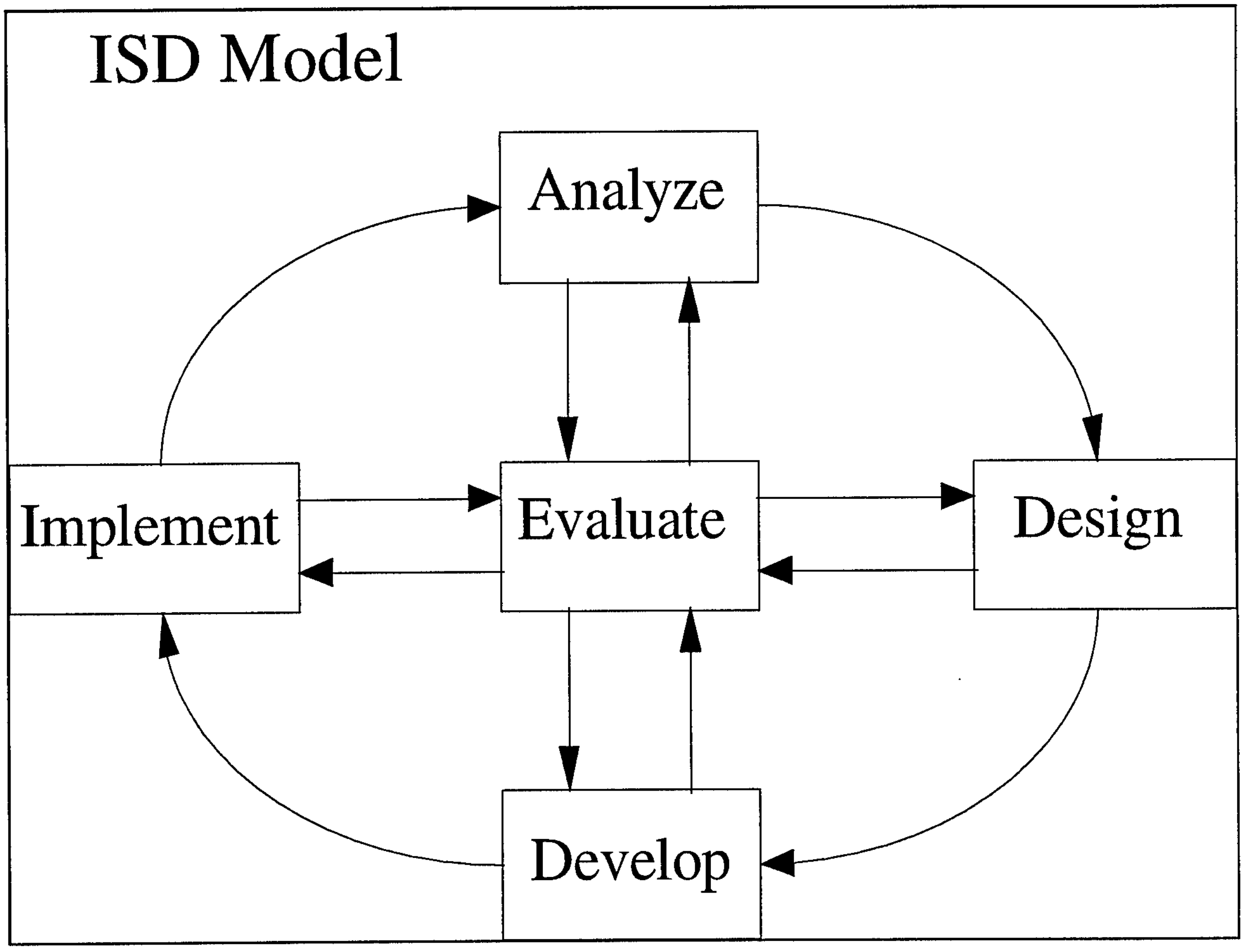

Figure 2-1. Instructional System Development Model

The ISD Model consists of five individual processes: analyzing a "system" to understand it completely, designing a method to achieve the desired outcomes, developing the courseware to achieve the outcomes, implementing the resulting courseware, and then evaluating the development system throughout to validate the process and the results.

This model illuminates the individual processes critical to Air Force TRED programs. The successful military education or training program rests on the capability to develop efficient and effective courseware and the tools to execute that curricula. The ISD Model tells us a successful TRED program requires: an accurate awareness of specific service needs, the specific

knowledge, skills, and aptitudes (KSA) required to execute military operations, and the ability to accurately measure students' KSA before, during, and after training.

Life Cycle

A generic life-cycle model depicts the cradle-to-grave nature of institutional education and training (fig. 2-2).

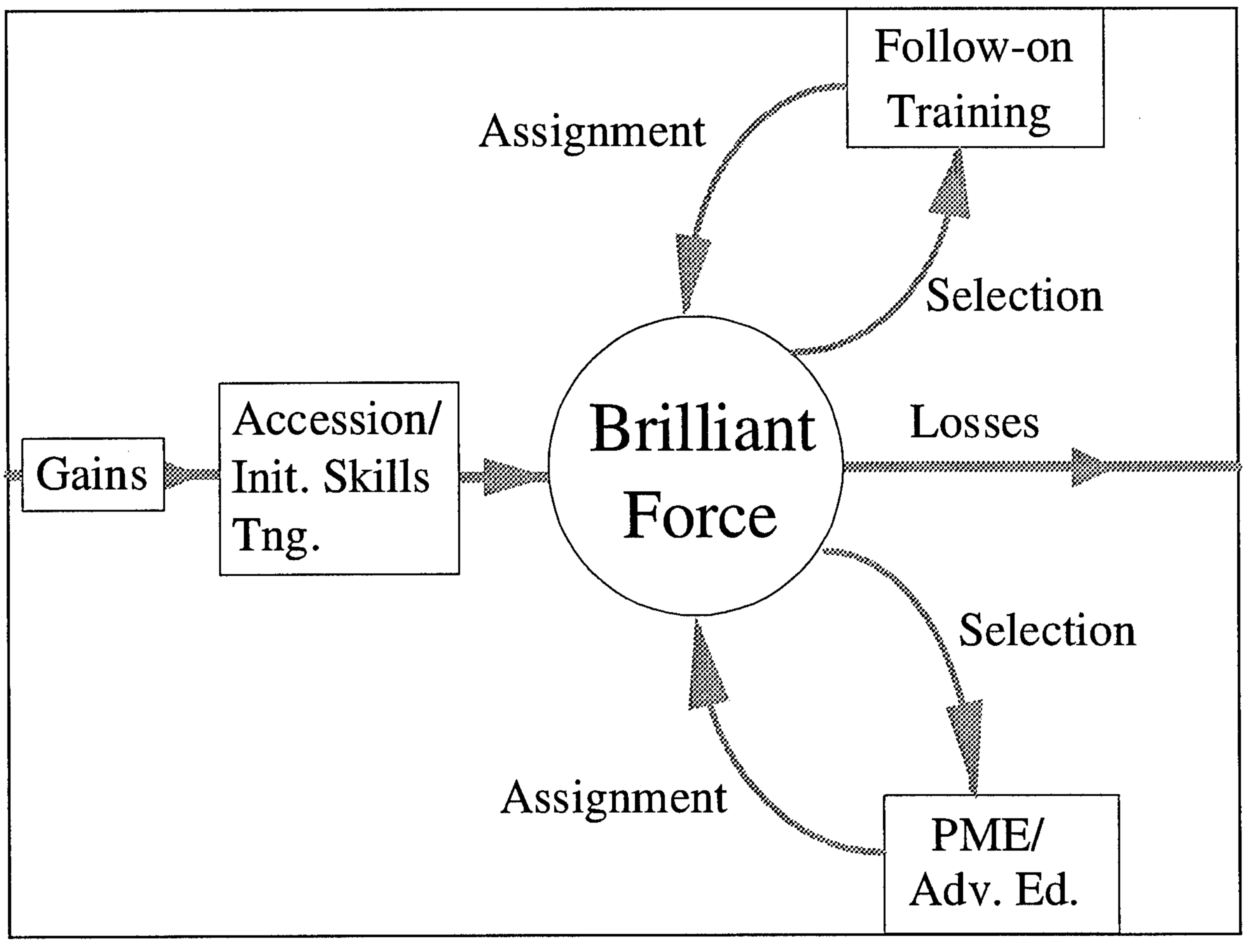

Figure 2-2. Life-Cycle Model

The life-cycle model illuminates those processes external to actual TRED programs that impact the brilliance of the force. They include accession programs and policies, advanced TRED selection mechanisms, post-TRED placement policies, and retention tools.

Drivers

Developing a coherent vision for ET2025 requires at least a rudimentary understanding of the world in which it must operate. Christine A. Ralph MacNulty of Applied Futures offers insights into the process of mastering the future. She argues one key to future success is understanding what is happening in the external operating environment: to assess the spectrum of activity external to the organization, particularly with respect to developments in social, technological, and other driving forces.[2] A second essential to preserving the future is to look at an organization—or, for our purposes, a process—and understand its purposes and functions, how those functions could be performed better, and whether these will continue in the future. Having already addressed the former—purpose and function—we can answer the latter only with some understanding of the environment of 2025—and of the drivers that will create and enable it. We shall examine four such drivers that will be critical to the education and training process (fig. 2-3).

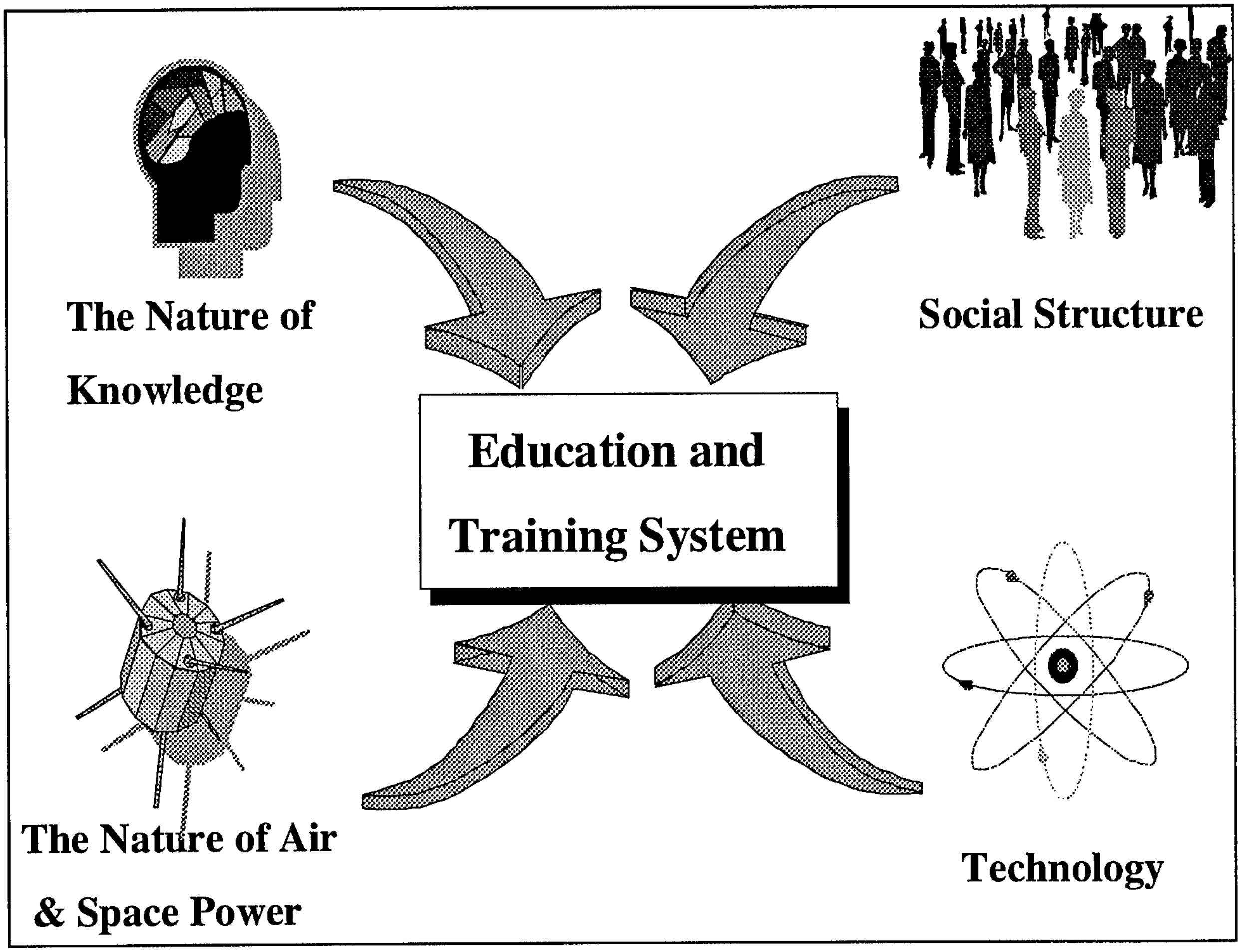

Figure 2-3. Drivers

Social Structure

The warriors of 2025 will come from the "knowledge society," a society enmeshed in the information revolution. This information society will demand more and more "knowledge workers"—workers having significant formal education and the ability to acquire/apply theoretical and analytical knowledge. However, this demand will occur in a society that may be unable to produce the required quantity of knowledge workers. In *The Road to 2015* John L. Peterson notes two trends heightening demand for knowledge workers in the future: an aging US population and an education system that graduates too many students ill-equipped for an information-based economy.[3]

Additionally, the warriors of 2025 will enter the service with different generational baggage from the warriors of 1995, or even 2005. Growing up in the technological age, they will be comfortable with computers, video games, and instant access to information. They also will be less patient, more accustomed to instant gratification, and demand stimulation, excitement, and speed in their lives. And they might seek out the military for challenges and responsibilities not found elsewhere.[4]

Technology

Revolutionary and evolutionary technological development will challenge ET2025 in several ways. Technology will dramatically and rapidly change the tools of war and drive changes in the KSA required to wage war. The rapid pace of technological innovation also will require military professionals to anticipate the impact of emerging technologies on war-fighting capability and assess the implications of technological breakthroughs. ET2025 must be agile and flexible enough to satisfy these demands—and it must adapt to TRED challenges and opportunities more efficiently than our adversaries. Additionally, ET2025 must be flexible enough to incorporate emerging technologies as they apply to the learning process.

Nature of Knowledge/Learning

The changing nature of knowledge will have a significant impact on ET2025—it will truly be not what you know that is important but what you know. The exponential increase in what we know and what we learn will continue to make "knowledge" and "understanding" increasingly fleeting states of mind. It is becoming increasingly difficult to "know" and "understand" at levels

of the past. In 2025 we will have to know how to know, how to decide what is important to know, to know what we don't know, and how to go about getting it.[5]

The nature of what we know will challenge ET2025, as the fundamentals that served us well in the past will fail us in the future. In *The Age of Social Transformation*, Peter F. Drucker provides insights as to how our definitions and concepts surrounding the TRED process must change with the changing nature of knowledge. First, he argues that the quest for and accumulation of advanced knowledge must continue well past the age of formal schooling. Next, he writes, our vision of an educated person must evolve. An educated person will be someone who has learned how to learn and who continues to learn throughout his or her lifetime. Further, a formal degree or testimonial will no longer validate someone's education, performance capacity will. Additionally, learning will become the tool of the individual, and knowledge will exist for the most part only in its application. Finally, Drucker believes the generalist will exist no longer.[6] This new methodology will dictate better use of "teams" to solve problems, since it will become increasingly difficult for one individual to grasp all necessary knowledge.

Closely related to the nature of knowledge is the nature of learning, which plays a complementary forcing role in envisioning ET2025. Leaps in our understanding of the cognitive process itself will offer insights into the nature of learning and provide opportunities to enhance the learning process. This growing sophistication about the nature of learning, for example, points towards individual learning and customized learning environments as critical concepts in an effective and efficient educational process.[7] Future discoveries in areas of nontraditional intelligences—spatial, musical, kinesthetic, interpersonal, and intrapersonal—also may offer opportunity to exploit new venues for educational purposes.[8]

Nature of Warfighting

The nature of 2025's military forces will drive the TRED process that supports it. Two characteristics deserve our consideration. First, if current trends serve as a benchmark for the future, the military forces of the United States' must be prepared to participate in operations of varying complexity, from low-intensity conflict through full-scale war and across the ever-growing spectrum of "operations other than war." Concurrent with a commitment to a wide variety of missions, a United States that becomes more inextricably engaged around the world will commit its military forces to a high operations tempo. This tempo will distinctly impact the design of ET2025: forces generally will not be available to support long-duration TRED programs, and this ops tempo will limit the opportunities to train on operational systems.

ET2025 Imperatives

The brilliant force that will dominate the 2025 battlespace will require a TRED environment—ET2025—to do so. ET2025 must incorporate the characteristics—and critical internal and external process illuminated earlier--and do so in the world of 2025 as suggested by the drivers. ET2025 must demonstrate certain operational characteristics and satisfy critical military needs. These, taken together, form the ET2025 imperatives:

- ET2025 must prepare brilliant warriors and leaders to act decisively in ambiguous and changing environments. It must prepare technologically aware and adept warriors. It must focus on developing wisdom instead of knowledge and on acquiring how to learn techniques as well as critical skills.

- ET2025 must provide the opportunity for continuous learning, on demand, any time, and anywhere. It must ensure minimal loss of productive job-related activity.
- ET2025 must recognize and adapt to individual differences. It must tailor TRED programs to each individual, his or her immediate TRED needs, and individual preparation and inherent cognitive and physical skills and aptitudes to achieve an optimum learning style.
- ET2025 must overcome barriers to effective learning within technological, physiological, and ethical constraints. It must incorporate technologies and learning environments that will increase human performance.
- ET2025 must be agile and flexible in responding to a rapidly changing external environment. It must quickly recognize emerging TRED needs. It must possess an agile and a responsive curricula development process. It must adapt and incorporate emerging TRED technologies.
- ET2025 must take advantage of improvements in simulation and modeling technology to provide realistic individual and team TRED alternatives. It must incorporate technologies to create virtual realism, to introduce human behavior into the simulation process, to network individual simulators for group and small-unit training, and to provide cost-effective training alternatives.
- ET2025 must enhance Brilliant Force by exploiting obvious synergism with service personnel management tools. It must exploit personnel classification technologies that enable matching personal KSA with required job skills. It

must match TRED programs with follow-on job requirements. It must enter into a partnership with accession, retention, selection (for TRED programs), and assignment policies to increase total-force capabilities.

- ET2025 must exploit education and training partnerships with sister services and national agencies, civilian universities, and commercial training programs. It should focus on those KSA unique to Air Force and military operations and seek to consolidate education and training for more common TRED requirements.

Notes

[1] Lt Gen Jay W. Kelley, "Brilliant Warrior," (Unpublished article, Maxwell AFB, Ala.: Air University, 1996), 4-5.

[2] Christine A. Ralph MacNulty, "Social Change: The Often Ignored Driving Force" (Paper for the Industrial College of the Air Force, 20 January 1995), 2.

[3] John L. Peterson, *The Road to 2015: Profiles of the Future* (Corte Madera, Calif.: Waite Group Press, 1994), 15.

[4] Kelley, 7.

[5] Although deciding what is important to know (and, therefore, what is important to teach) is a critical element of any training or education program, we do not address it in this paper. Our emphasis is on building a system and a process which will enable the military of 2025 to teach anyone, anything, at any time. Thus, the *what* becomes less important to identify in advance as the *how* becomes more efficient and responsive.

[6] Peter F. Drucker, "The Age of Social Transformation," *The Atlantic Monthly* 274, no. 5 (November 1994): 64–68.

[7] Individual learning is the focus of this paper. Team training, as in unit readiness training, will remain a necessity for the Brilliant Force of 2025; however, this paper does not discuss the processes or materials related to group training, except where they overlap with individual education and training.

[8] Jan Davidson, "White Paper: Multiple Dimensions to Learning," 1–5. On-line, Internet, 15 March 1996, available from http://vital.davd.com/vlpress/white.html.

Chapter 3

System Description

The models, drivers, and assumptions above shape the TRED system to optimize learning in 2025. The ET2025 architecture is "agile education," a combination of just-in-time training, training on demand, and tailored training made possible by expected advances in artificial intelligence (AI), virtual reality (VR), holography, and communications and computer technologies. Within the agile education system, the concepts of the national knowledge superhighway (NKS), academic centers of excellence, expert tutor (EXTOR), distance learning, and hyperlearning receive special attention. An additional section discusses the need for sophisticated screening processes to better match individual capabilities with military needs and some of the technologies under investigation.

Agile Education

The military TRED community has investigated the concepts of just-in-time training, training on demand, and tailored training for a number of years, but no coherent plan for implementing these ideas has emerged. The value of such initiatives should be obvious: training tailored to the individual and the job to which he or she is assigned, provided when and where convenient to the trainee/trainer, would save the military time and money and make the force more flexible.

At the current time, service training and education caters to the average trainee and takes a predetermined length of time, regardless of the individual abilities of the students. For example, undergraduate flying training (UFT) students begin training on the same day, complete the same number of training sorties, and graduate a year later. The aforementioned system has been termed a pipeline: students crawl in the training pipeline together and pop out the other end in a clump, ready for assignments to the operational force. In times of dwindling budget and manpower, the pipeline is not (if it ever was) an efficient method for training.

Curiously enough, the world of manufacturing has a concept we can borrow and apply to TRED. It's called agile manufacturing. Agile manufacturing is the latest trend in industries where mass marketing has given way to "niche" marketing, where mass production of a standardized product has evolved into mass customization of personalized goods.[1] For example, the computer industry already has embraced agile manufacturing to a great extent. The customer can order a computer over the phone, specifying the precise processors, memory, monitor, and peripherals desired. One of the main purposes of agile manufacturing is "to get the product from concept to marketplace very quickly."[2]

Considering an appropriately trained and educated military member as the "product" and the gaining commands or agencies as the "marketplace," one begins to see the possibilities of agility when applied to TRED. Alphonso L. Hall, a plant manager for General Motors and a guru of agile manufacturing, talks of an agility analysis which is a "rigorous cost, responsiveness, quality, and performance test that can be applied to equipment, processes, and people. In addition, the test asks whether or not equipment and people are reconfigurable to make new products, and if the products themselves are reconfigurable."[3] The four standards Hall applies—cost, responsiveness, quality, performance—could equally well apply to TRED. Simple changes in

language show how easily we can transfer the concepts of agility to TRED. Military personnel are, of course, "reconfigurable" through TRED. The military should aim for truly agile education or agile TRED by 2025. Such a system would respond virtually instantaneously to the needs of the customer by identifying and teaching the right individuals to accomplish the mission—a combination of the tailored training and just-in-time concepts floating around now.

Consider the following scenario. It's 2025. A cyberterrorist group has threatened to destroy France's economy if their demands aren't met. The US responds to France's plea for assistance, and the secretary of defense asks the JPC (Joint Personnel Center) to assemble a team to stop the terrorists. Skimming through their databanks of information about individuals' skills, knowledge, aptitude, and learning ability, JPC personnel identify 20 people for the task force. Agile TRED specialists immediately assess the TRED needs of each of the task force members and construct individualized programs (using virtual reality, simulation, and AI "agents") which the members complete at their current locations. Some members receive only one or two blocks of instruction, some receive six, seven, eight . . . whatever they need, based on their current KSA levels and the task they must complete. Completely trained for the mission, the task force assembles (physically, if necessary) and neutralizes the cyberterrorists. They disband and return to their previous jobs or go on to new assignments, receiving necessary training en route.

To accomplish missions like these, the services need a new paradigm for training. The omnipresent image of a superhighway may be useful in reorienting our thinking away from the pipeline metaphor. The new TRED system should more nearly resemble an infinite highway with on-ramps and exits convenient to the trainee. The trainee will get on the highway at a point convenient to him or her and congruent with his or her current KSA and mission assignment. The trainee will exit the superhighway when he or she has learned the tasks or materials required or

desired. No longer will military personnel be trapped in a pipeline, waiting to complete unnecessary blocks of education or training and awaiting a preordained graduation day to move on to their gaining unit. The new system should allow students to enter training at whatever point their individual abilities dictate, give them precisely the training they need, and certify them when they've mastered the tasks/ideas, not on a predetermined date.

National Knowledge Superhighway

Agile learning has one prerequisite which training and education have required: courseware designed in collaboration between subject matter experts and instructional program developers. However, the imperatives of ET2025 dictate that much of the curricula take a different form and function. The requirement for an agile curriculum development process, distance learning capabilities with learning on demand, and an active learning experience dictate the need for two critical system components: a central server hosting expert interactive courseware and specific training modules to serve the critical TRED needs of all DOD distant end users (the national knowledge superhighway) and a software-driven automated courseware development system incorporating expert systems technology to support it.

The automated courseware development system is a natural extension of the computer-aided design/engineering systems in use today. It incorporates emerging expert systems technology, the ability to automate production rules associated with instructional systems development, and the ability to model and replicate the human learning process to rapidly develop expert interactive courseware to support our national TRED needs. Likely to be available to courseware developers well before 2025, this capability will be essential to ensuring military forces can adapt quickly to the rapidly emerging TRED requirements of 2025.

While the technical capability to develop expert interactive courseware likely will exist before 2025, the ability to rapidly develop TRED tools in response to emerging requirements will face formidable challenges. In "Advanced Training Systems for the Next Decade and Beyond," R. Bowen Loftin and Robert T. Savely, note that one of the greatest barriers to the development of expert systems has been, and likely will continue to be, the acquisition of the expert knowledge of a particular skill, task, or aptitude necessary to develop production rules.[4] Course content teachers and subject matter experts will remain critical nodes in ET2025. The expert courseware supporting 2025's NKS will depend on the military's ability to understand and to catalog/classify the specific KSA associated with each specialty and/or TRED objective. It will depend also on the capability to translate this expertise into a form exploitable by expert interactive teaching tools.

The NKS enables ET2025's architecture to support the overarching notions of agile learning with tailored, on-demand, just-in-time learning capabilities available at a distance. It hosts the resident interactive courseware and training modules and links distant end users with the subject matter experts located in various DOD and accredited civilian centers of excellence. Similar in theory to the information superhighway, the NKS differs significantly in practice. It hosts not unfiltered information but accredited, interactive courseware designed to support initial skills training, follow-on refresher training, and the advanced education needs of military forces operating on land and sea and in the air and space. Further, it is secure. It will maintain strict access controls, allowing only specific courseware developers to place educational materials onto the server.

Academic Centers of Excellence

Selected DOD and civilian institutions—the ET2025 Academic Centers of Excellence (ACE)—form the backbone of the agile learning capabilities of 2025. These centers of excellence, often the same sites responsible for developing the remaining resident TRED programs for the military and civil service forces (Maxwell Air Force Base (AFB), National Defense University, Fort Leavenworth, Harvard University, and other similar places), will be responsible for developing solutions and anticipating or reacting to existing and emerging TRED requirements. We anticipate each service will have one or more ACE to support service-specific TRED needs, and each service will provide the primary materials necessary to support the TRED requirements of joint and coalition forces.

ACE will be critical nodes in 2025. The best institutions will not merely add new technologies to their existing twentieth century structure. Rather, top-quality ACE will act as facilitators of learning; they will be repositories of the best in education and educational systems, ready to tailor the program to the needs of the students. Information technology will continue to reduce the need for students to travel to the information; educational centers will excel in moving the information to the student, reducing travel costs, and supercharging education and training agility.

> The critical roles of an "electronic" educational institution built to meet the learning needs of the 21st Century will be as follows: to provide information on education and training needs and opportunities; to provide quality control; to provide accreditation, through independent assessment of learning; to develop coherent curricula, where appropriate; to broker and validate courses and materials from other education and training suppliers; to make it easy for teachers and learners to use communications technology to import and expert multimedia learning materials; to network learners and instructors; to create high quality educational multimedia materials in an easily accessible form; to conduct research into education and training needs; to apply new technologies, as they develop, to education and training, and to evaluate their use.[5]

On the other hand, our DOD campuses will not become "ether" universities. Critical skills essential to effective military operations—leadership, discipline, motivation, teamwork, team building—will still require face-to-face interaction. But the electronic medium will reduce the amount of time spent in conventional classroom learning situations. Students will accomplish these lessons at home or at their assigned stations.

Clearly though, a center of excellence must evolve over the next 30 years to fulfill the need for high-quality educational multimedia curricula. This center of excellence, whether a pure DOD endeavor or a partnership with private industry, must be capable of producing large quantities of complex interactive training software for the highly capable educational systems of 2025. Air University at Maxwell AFB is the logical choice to lead in this role.

The academic centers of excellence will provide the courseware input to the education and training architecture of 2025. A new capability—the expert tutor—will help to manage the output.

Expert Tutor

The expert tutor (EXTOR) will provide the interface between ACE and the end user—the student. An individualized, personal expert interactive training aid, EXTOR will satisfy many ET2025 imperatives. Focusing on knowledge application and learning, it will allow the user continuous learning opportunities. It will also tailor the learning process to the individual's specific TRED needs and inherent cognitive skills and learning style, and it will incorporate state-of-the-art technologies for learning enhancement and virtual realism.

EXTOR is the generation after next of the computer aided instruction (CAI) capabilities currently in use in many training environments. Interactive Courseware documents many of the

systems' benefits in the TRED environment: increased training effectiveness, increased student participation and interest, increased knowledge retention, reduced time in training, reduced attrition levels, and reduced life-cycle training costs.[6] Clearly, CAI is congruent with ET2025's imperatives: it is reasonable and prudent to assume third- or fourth-generation CAI systems will be an integral part of and critical to the success of ET2025.[7]

NASA's intelligent computer-aided training (ICAT) capability has taken CAI to the next level, demonstrating impressive results in the application of expert systems to CAI. A modular system designed to emulate the behavior of an experienced instructor in the training process, ICAT has demonstrated the capability to provide trainees with much the same experiences as they could gain from the best on-the-job training programs.[8] EXTOR will take CAI at least one step beyond ICAT. Evolving from further research into expert systems, it will use expert systems and artificial intelligence to convert CAI into an instructional media to instruct, diagnose, and evaluate.[9]

Part of a modular, global learning environment, EXTOR enables and promotes active and individual distant learning. It is the expert computer interface to link the end user (student or trainee) with interactive courseware resident on the national knowledge superhighway (NKS). Serving as each individual's personal assistant, it will access information from available sources and present it in a format suited to the user's individual learning style. EXTOR consolidates many of the functions performed by NASA's ICAT system into a single, user friendly software interface performing the many functions. It allows the learner access to distant courseware and information via the NKS and NDB manages the training session carries out active and interactive tutoring based on its knowledge of the individual's optimum learning style watches for common student errors and provide corrective feedback maintains and updates a database containing

trainee's performance history and designs and executes increasingly complex training exercises based on its knowledge of the course objectives and individual's current KSA level and demonstrated weaknesses.[10]

EXTOR will be a lifelong learning companion for each service person. First used during accession testing, it will replace the current battery of skill and aptitude tests. It also will map each individual's KSA to determine suitability for Air Force operations and assist in initial placement. Mapping each individual's learning styles, it will determine the optimum learning approach to apply in subsequent training sessions. EXTOR also will serve several valuable institutional functions. It will perform personnel diagnostic, tracking, and assessment functions to assist in accession measurements and decisions, personnel classification systems, active skill-level certification, and selection processes for advanced training, follow-on education, and assignments.

EXTOR will require the integration of several critical technologies currently undergoing research on a limited basis and will require their availability on a wide scale. These requirements will include advancements in cognitive modeling and the ability to model the learning process; the development of expert systems, including the use of neural networks and fuzzy logic; the ability to acquire or develop knowledge to interface with EXTOR; and the development of virtual reality creation techniques to build and exploit each individual's optimum learning environment and learning style.

The combination of the first two technologies—cognitive modeling and the ability to model the learning process—will underpin the EXTOR of 2025. Current research into the study of the nature of knowledge and of human learning will result in the theoretical constructs necessary to build 2025's expert tutors. Fuzzy logic and neural networks, among other alternatives and

advancements in cognitive modeling techniques, may enable 2025's expert tutor to understand and to adapt to individual growth and learning processes. Loftin and Savely suggest fuzzy logic and neural network technologies will enable expert tutors to represent student mental states more accurately, assess individual KSA development and learning patterns, model individual trainees, adapt training to the individual's behavior to provide the optimum learning environment, and track and respond to complex lines of inquiry.[11]

EXTOR will also leverage state-of-the-art virtual environments to enable fully interactive distant learning. Cost has been one of the limiting factors in the application of virtual reality to the education and training environment. However, costs should decline in this area sufficiently by early in the twenty-first century to make this technology affordable for educational institutions.[12] By 2025, the technologies associated with virtual reality should enable this capability to be exploited for education and training purposes on a far-reaching scale.

Combining intelligent CAI with other emerging technologies and developments in advanced cognitive research offers great potential for further significant advances in autonomous, self-directed education and training tools, mainstays of agile TRED. According to the authors of "Plugging In: Choosing and Using Educational Technology," computer-based technologies derived "from artificial intelligence and research in cognitive science promote [active] learning. Such systems help learners think through complex, authentic problems; take charge of their own learning; and develop products for teaching or use in the real world."[13] The authors also state these systems, together with expert instructors, integrate media to provide sophisticated expert systems for learning complex concepts, help students develop advanced learning skills, diagnose student performance, adapt the level and sequence of problems based on student performance

and suggest directions for future learning, and simulate the use of emerging technologies and decision making to address complex real world problems.[14]

The EXTOR and its associated capabilities embody a key concept to lead the Air Force closer to agile TRED, with particular emphasis on tailored TRED available on demand. A notional system is depicted below in figure 3-1.

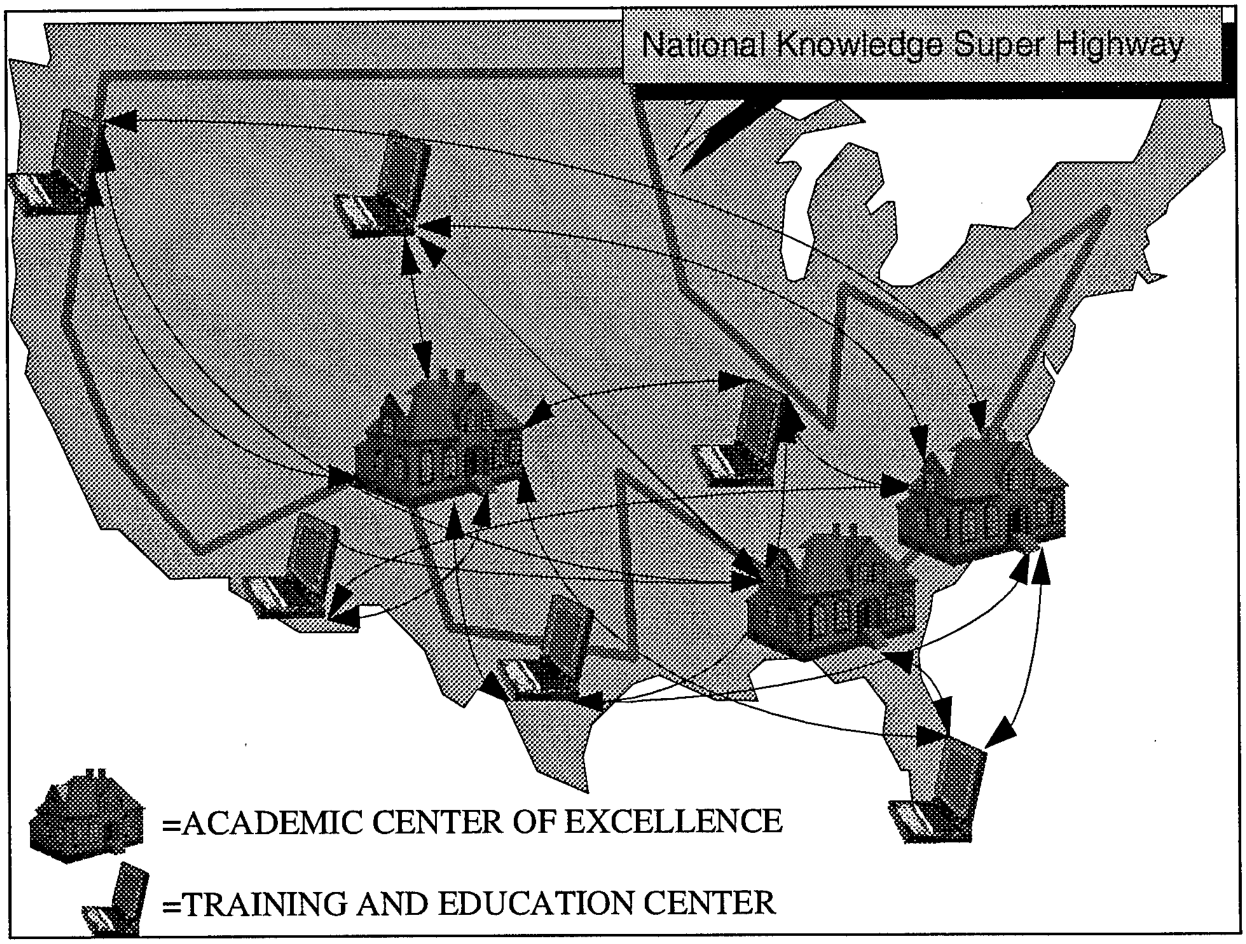

Figure 3-1. Notional System Model

Distance Learning

The armed forces are no stranger to the distance learning concept, and considering the aforementioned drivers and required capabilities, the stewards of air and space power would do

well to position themselves to take further advantage of advances in this area. Distance learning may be the bridge to connect Air Force TRED in 1996 to the truly agile system postulated for 2025.

Both now and in the past, distance learning in the military has been a small, albeit significant slice of the education "pie." Correspondence courses have filled selective niches, mostly to provide PME courses in lieu of in-residence attendance. However, the assumptions and drivers discussed earlier require a change to this limited approach to distance education. Obviously, the services must develop the capability to increase the availability, quality, and quantity of training and education to meet the demands of mission complexity; and we must be capable of doing it cheaply and efficiently. The distance learning concept of operation may hold the key to tackling the challenge.

The distance learning concept is gaining steam in the business world. AT&T's Center for Excellence in Distance Learning is giving industry systems that provide interactive visual teaching or training where the instructor and students are geographically separated but connected by electronic media. AT&T reports several benefits from this learning concept, including reduced travel costs, the flexibility to add students as needed without incurring additional expense, real-time course material updates, access to remote experts, and the ability to train more people and to do so more often.[15]

Clearly, the distance learning concept addresses many of the required air and space TRED capabilities for ET2025. Additionally, much of the technology to make distance learning effective is already available and in use. Consequently, the question now becomes one of predicting the advances in distance learning concepts and technologies—in such areas as signal

processing and display technologies--over the next 30 years and the actions the services must take to leverage advantages in this concept.

For example, effective, compelling, and efficient distance learning will require an improvement in signal-processing technology. An all-optical network would expand capacity so that the exchange of video and large computer files would become routine.[16] Although all-optical networks are now in their infancy, we may assume that optical networks, or another as yet undiscovered signal-processing technology, will erase the current limitations in network communications by 2025.

Likewise, advances in display technology could well revolutionize the distance learning concept. Currently, most display technology is based on the ubiquitous cathode ray tube, a technology developed more than 50 years ago. New display technology, whether holography or another new technology, may truly change the way we interact with digital information. Peterson points out that "if holographic information can be digitized and therefore transmitted (assuming adequate bandwidth) to remote locations, a whole new era will open up. 'Picturephones' may project the person on the other end of the line into the middle of your room as a 'light sculpture.'"[17]

It is one thing to read the script of the president's speech on your computer screen; imagine if the president were able to present the speech live, in your own living room or study, through the medium of a 3-D holographic image. More significantly for TRED purposes, imagine the greatest professors and thinkers of the day in your own living room, teaching you. A concept from the 2025 study, "Holographic Meetings," suggests using this same technology for meetings, rather than education. This dual-use technology could present benefits in several arenas.[18]

Thirty years from now, advances in virtual reality technology could make each air and space professional's home a virtual education "center of excellence." As software evolves and computing power increases, virtual reality will be used to present models of all kinds of complex dynamic systems. Soon it will be possible to engage multiple senses simultaneously, engendering a total response from the mind and the body that will be more than the sum of its parts.[19]

Hyperlearning

The current teaching paradigm emphasizes, as described by Asghar Iran-Nejad and George E. Marsh II in *Discovering the Future of Education*, a focus on the memorization of various concepts and facts, thereby effectively fragmenting the learning process to such a degree that the results are inapplicable to the real world.[20] This cognitive learning paradigm holds that knowledge has a separate existence from the physical nervous system--it can exist outside the learner, waiting to be memorized and internalized. Current curricula generally mirror this cognitive structure; important knowledge is identified as a "sample of behavior" or some other sort of objective. By highlighting these critical knowledge "nuggets," we attempt to simplify the internalization of knowledge by breaking these mountains of data into manageable pieces. The information revolution has reinforced this concept: computers process and store information, then they readily reproduce it as required. As Iran-Nejad and Marsh explain:

> Another implication is that there is no more to learning than storing information. Thus, even in modern cognitive neuroscience the brain plays an incidental role in memory and virtually no role in learning beyond memory, as many leading neuroscientists view brain components as being more like static storage disks than biological subsystems with critical roles to play. As a result, anyone familiar with how computers process and store information can play the role of an expert on learning.[21]

This paradigm cripples our ability to apply new knowledge to real life. Further, it may degrade our ability to learn information efficiently and effectively. Infants learn at an exponential rate without having the ability to cognitively memorize and internalize. Rather, infants learn by sensory stimulation, by actively solving real-life problems, and by experience. "Children are born with a remarkable capacity to learn and they do learn successfully from whole-brain experiences during the first few years of their lives until, that is, they enter school."[22] This "whole-brain," experience, or hyperlearning, is central to our concept for learning in 2025.

The hyperlearning concept acknowledges the unique capacity of the brain to learn when immersed in a total learning environment, and it rejects the old paradigm of the brain as computer. People learn most effectively through whole-brain experiences rather than rote memorization of facts and concepts. The human brain does not evolve as a solution to memory requirements; rather, its evolution is the result of intentional and sometimes spontaneous responses to problems in natural environments, where inputs and stimuli to multiple senses are available simultaneously to contribute to learning.[23] What form would this system take, and might it be available in 2025?

> If education is to improve, and it must improve if our society is to continue to thrive in an increasingly complex and competitive world, teachers must be experts in human learning and development and not just subject-matter technicians. *At the base of this is the ability to devise a system that relates instruction to real-world applications.*[24]

The recent Star Trek movie, *Generations,* began with the characters conducting a promotion ceremony on the deck of a sailing ship. In the movie, the sailing ship, as well as the entire ocean environment, were depicted as a virtual reality simulation produced by a device called a "holodeck." Advances in virtual reality by 2025 could make the holodeck concept a viable answer to several required capabilities. More importantly, such a system would actively support

the hyperlearning concept.[25] Current trends in simulation technologies demonstrate some movement towards this concept.

Air Force flying training, a major user of simulators and simulation technology, provides some insights into current simulation efforts. For starters, the current generation of simulators is hardware intensive. As an example, one of the most recently acquired and complex simulators, the B-1B Weapon System Trainer (WST), relies on several large mainframe computers for digital processing and two large cockpit sections (for both pilot and aft stations), each mounted on a complex three-axis-of-motion hydraulic system to simulate flight. Several large cathode-ray tubes make up the visual (outside the cockpit) system. Actual panels and displays, including disarmed ejection seats, make up the cockpit. Consequently, the entire system is large, expensive, and maintenance intensive.

Two Air Force Institute of Technology (AFIT) programs demonstrate the movement towards virtual simulators and away from system-specific physical simulators. The first program, the virtual cockpit, is a low-cost, manned flight simulator of an F-15E. The pilot flies the simulator using a hands-on throttle and stick (HOTAS) and has the capability to drop bombs, as well as fire rockets and guns. What makes this simulator different from everything used in the past is the revolutionary display system. The pilot observes the in-cockpit and out-of-cockpit imagery through a head-mounted display. The only physical instrumentality in the Virtual Cockpit is the HOTAS.[26]

The second AFIT program provides us with another example of the move towards virtual simulation and of its benefits. The virtual emergency room will be a "state-of-the-art virtual reality environment for use within emergency rooms."[27] Doctors will be able to access virtual records, monitor a "patient's" vital signs, and view radiological and other diagnostic data. Virtual

patients will test each doctor's ability to respond to trauma, aneurysms, poisonings, and other time-critical medical emergencies.

The move towards virtual simulation offers another advantage: the ability to be networked to expand training realism. The simulation lab at the Institute for Defense in Alexandria, Virginia, provided the central effort in the development of the SimNet system. Through SimNet, participants around the world are networked together and fight on a virtual battlefield. Peterson describes one such scenario.

> Ships in the Pacific can have real-time radar displays that look like the "battlefield" located in North Carolina. Army tankers in trainers in Fort Knox, Kentucky, look out of their sights and see the same location-only from each of their individual perspectives. Air Force pilots in California can "fly" missions in support of other participants from their trainers at the same time.[28]

Clearly then, the next generation of simulation technology will have several ground-breaking characteristics. First, there will be intensive use of virtual reality display systems to improve simulation realism to "suspend disbelief." Also, the new generation of simulators will be software intensive rather than hardware intensive. Next, simulators will be increasingly networked to expand training opportunities. And, finally, the services will exploit simulators in areas of endeavor other than flying training, such as the medical simulation noted above.

The question now becomes, "What will simulation training look like in 2025, and how should the air and space forces leverage themselves to take advantage of developing concepts and technologies?" It is reasonable to assume advances in display technology, computer processing speed, and signal processing will make simulators even more realistic, software intensive, and network capable. It is also reasonable to assume more and more training and education--both flying and nonflying--will be done in simulators. These advances in technology, along with an increasing reliance and emphasis on simulator training, may lead to a merging of simulator

training into a single simulator platform, much like the holodeck previously described. Users would enter the holodeck and direct the computer to load whatever simulation program they needed, whether an emergency room simulation, a flying mission, or an airfield defense scenario. Enhanced realism and network capabilities would make possible highly realistic, inexpensive, and possibly more frequent joint training exercises. This software-intensive system would reduce the need for expensive, single purpose, maintenance intensive hardware-based simulators. We could afford more of them. The simulators could meet a wide variety of training needs, including flying training, surgical procedures, bomb disposal, base defense, and air traffic control--all in the same versatile simulator platform.

The realism inherent in this platform also could provide otherwise unavailable training. If current trends continue, increasing air traffic, along with increasing urbanization, may seriously impact the availability of actual flight training, especially in the low-level regime. Low-altitude simulator training, with realism sufficient to "suspend disbelief," is just one example where the capability of "superrealistic" simulators could overcome environmental limitations.

The networking capabilities of a holodeck style simulator opens up a vast number of training and education possibilities. Complex joint exercises could be accomplished entirely in the ether. Students completing professional military education could network in a virtual classroom then work through a significant crisis like the planetary defense action of 2015. Leadership training scenarios, from the battlefield to the Air Operations Center, could be simulated with convincing realism. The possibilities are limited only by imagination.

Such a virtual system boasts many advantages that answer numerous required capabilities: being software intensive, it would be relatively inexpensive as well as easy to update; it would answer the problem of difficult environmental constraints to realistic training; and, it would

provide realistic training for complex real-world scenarios. Most importantly, the system would conform to and shape the new paradigm of hyperlearning. Participants would be immersed in a total learning environment, bathed in sound, light, and sensations of touch, smell, heat, cold, and pain. Through rich combinations of highly realistic sensory stimulation, realistic problem solving, and the total suspension of disbelief, we may be better able to exploit our exponential learning capabilities.

Enhanced Screening

Enhanced screening capabilities are a necessary precursor for agile TRED, the overall concept that incorporates the ideals of just-in-time learning, learning on demand, and tailored learning.[29] To minimize the demands upon the education and training process and to enhance the overall quality of the Brilliant Force, the military must be able to identify and select the right person to receive the right training at the right time.

When we think of screening today, we think of testing: physical, emotional, and mental. We screen a person's health with X rays, family history questionnaires, blood tests, and eye tests. We screen physical ability with tests of strength, dexterity, speed, and flexibility. We screen mental ability with psychological and intelligence tests. People are asked to interpret inkblots, to indicate preferences, and to make word associations to understand their personality and behavior traits. Intelligence tests measure ability to reason, think, and recall information. These types of tests help employers to decide whom to hire and whether person A or person B is better suited for a particular task. Many corporations use the tests, and the results from these tests indicate they work. More and more, the corporate world is using screening techniques to make decisions about people and their training and education. Why? Because this method is a cost-effective

way to ensure time and money are not being wasted on the wrong training for the wrong employee.

Joseph Matarazzo, winner of the 1991 APA Distinguished Professional Contributions to Knowledge Award, indicates emerging tests and their offshoots may offer some "different approaches" to the screening.[30] For example, biological tests (such as electrocardiogram readings), nerve response reaction time measurements and brain-imaging techniques may prove useful in predicting human performance in certain areas. Matarazzo predicts advances in these biological-physiological-behavioral processes will help us to measure intelligence and cognitive capacities.[31] The emotional quotient concept submitted to the 2025 study suggests we measure and screen for "qualities of the mind like empathy, discipline, fairness, tenacity."[32] The author suggests such testing will allow the military to assess how an individual will react in a crisis situation more accurately. Using a variety of these screening techniques and then loading them into data systems will provide a multitude of opportunities for enhancing Air Force TRED in 2025. Indeed, accurate and updated screening is a prerequisite for the agile TRED system discussed earlier.

A variant of Armstrong Laboratory's Intelligence Tutoring System (ITS) could be used to predict someone's capabilities.[33] The futuristic versions of the ITS involve a VR tutor "with facial expressions and voice." The student learns in an immersive learning environment wherein the "learners can move their own hands to pick something up."[34] Not only will students learn tasks through kinesthetic feedback, they will have one-on-one lectures from VR tutors like Sun Tzu or Aristotle.

By immersing an individual into a VR situation, the ITS also can be adapted for screening. This variant—an intelligent screening system (ISS)—will provide individuals with a totally new

and unknown problem, evaluate the results of the individual's attempt to react and perform the desired tasks, and explore the individual's abilities to adapt and to learn. The ISS combines Matarazzo's measurement tools, data on the human brain, and advances in predictive neural-network technologies, which together might lead to identifying supercritical task ability. Imagine being able to identify and predict which individuals have the capacity for some presently unknown supercritical task. Or, not finding the perfect individual to accomplish a particular military task, imagine having the capability to identify the best qualified of those available for consideration. The military could not only identify the best qualified candidates, it could identify and tailor the specific type and quantity of training required to fully develop their skills—regardless of their initial knowledge or skill level. Advances in screening technologies need to be an integral part of the military's Brilliant Force architecture.

Notes

[1] Editors, "Custom Manufacturing," *Scientific American,* September 1995, 160.

[2] Brian Moskal, "Son of Agility," *Industry Week,* 15 May 1995, 14.

[3] Ibid., 12–14.

[4] R. Bowen Loftin and Robert T. Savely, "Advanced Training Systems for the Next Decade and Beyond," 1991, 10. On-line, Internet, 22 February 1996, available from http://www.jjsc.nasa.gov/ccsb/ica/docs/NextDecade.html.

[5] A. W. Bates, "Strategies for the Future," keynote address, n.p. On-line, Internet, 13 March 1996, available from http://oilpatch.scheist60.bc.ca/papers/dusseldorf.html.

[6] "Interactive Courseware." On-line, Internet, 18 April 1996, available from http://www.sc.ist.ucf.edu/~OTT/1_2/index.htm.

[7] 2025 concepts, no. 900088, "Interactive Books" and no. 900099, "Instructional Technologies to Enhance Leaders," 2025 concepts database (Maxwell AFB, Ala.: Air War College/***2025***, 1996). These concepts are essentially talking about EXTOR and its associated capabilities.

[8] Loftin and Savely, 2.

[9] "Interactive Courseware."

[10] Loftin and Savely, 6.

[11] Ibid., 10.

[12] Ibid.

[13] Beau Fly Jones et al, "Plugging In: Choosing and Using Educational Technology," 4. On-line, Internet, 26 March 1996, available from http://www.cic.net/ncrel/sdrs/edtalk/toc.html.

[14] Ibid.

[15] AT&T Center for Excellence in Distance Learning. On-line, Internet, 13 March 1996, available from http://www.att.com/cedl.

[16] Vincent W. S. Chan, "All Optical Networks," *Scientific American*, September 1995, 57.

[17] Peterson, 62.

[18] 2025 concept, no. 900680, "Holographic Meetings," 2025 concepts database (Maxwell AFB, Ala.: Air War College/***2025***, 1996).

[19] Brenda Laurel, "Virtual Reality," *Scientific American*, September 1995, 70.

[20] Asghar Iran-Nejad and George E. Marsh II, "Discovering the Future of Education," *Education* 114, no. 2 ( ): 250.

[21] Ibid., 253.

[22] Ibid., 256.

[23] Ibid.

[24] Ibid.

[25] 2025 concepts, no. 200007, "Rehearsal for all Missions, in all Mission Media, Without Vehicle Movement" (PROPRIETARY), no. 900643, "On-Platform Initial Flying Training," no. 900175, "Virtual Reality Trainers," no. 900516, "Generation X Theater Level Combat Simulation," no. 900534, "Virtual Force 2025," no. 900629, "VR for Cultural Competence," and no. 900680, Holographic Meetings," 2025 concepts database (Maxwell AFB, Ala.: Air War College/***2025***, 1996). These concepts outline various virtual reality/simulation ideas pertinent to 2025.

[26] Air Force Institute of Technology home page. On-line, Internet, 18 March 1996, available from http://www.afit.af.mil.

[27] Ibid.

[28] Peterson, 46.

[29] 2025 concepts, no. 900645, "Right Pilot," no. 900431, "Prescreening of Pilots," no. 900377, "Emotional Quotient," and no. 900569 900680, "`PRE-TRAINED` SERVICE PERSONNEL," 2025 concepts database (Maxwell AFB, Ala.: Air War College/***2025***, 1996). Concepts, , , and refer to the need for enhanced screening mechanisms and are incorporated in whole or part in this section.

[30] Joseph P. Matarazzo, "Psychological Testing and Assessment in the 21st Century," *American Psychologist* 47, no. 8 (August 1992): 1009.

[31] Ibid., 1013.

[32] 2025 concept, no. 900377, "Emotional Quotient," 2025 concepts database (Maxwell AFB, Ala.: Air War College/***2025***, 1996).

[33] Valerie Shute and Joseph Psotka, "Intelligent Tutoring Systems: Past, Present and Future," (Air Force Material Command: Brooks AFB, Tex., May 1994).

[34] Ibid., 41.

Chapter 4

Concept of Operations

Kelly was born in the year 2005. Kelly's childhood years were spent playing video and virtual reality (VR) games, with some physical playground activity with other children. In 2010 Kelly began school and spent hours in front of a computer terminal at the interactive school desk. Few books were issued as the information was either read, heard, or seen by way of the computer. Students took almost all tests on the computer. Typing skills were honed, and writing skills were marginal. By 2020 Kelly was talking to an interactive system rather than typing. Keyboards were backups.

In 2025 Kelly joined the United States military forces and underwent a series of psychological, emotional, and physical tests to evaluate cognitive and physical skills and aptitudes. In addition, Kelly's last five years of school work was added to the Joint Personnel Center's KSA database. The tests showed Kelly was best suited for service as an Interplanetary Defense System technician.

Initially, Kelly entered basic military indoctrination and training. Kelly joined a class of 70 other new recruits for a three-to-six week indoctrination program. During the first two weeks, trainees were subjected to "historical training methods" where they experienced 1996 methods of military training. They increased their fitness level through cardiovascular and strength training

exercises, shot nonenergy type weapons, were restricted to certain activities, and learned to work together as a group. The DOD retained this training because it provided a foundation for later operations and instilled backup military fundamentals should modern techniques be rendered unusable.

Following the two-week group interaction, the trainees began their tailored training programs. This phase lasted one to three weeks, depending on the individual. Each trainee spent several periods per day in the TRED center where an individually tailored EXTOR helped the trainee to develop the balance of knowledge needed for induction in the military. This knowledge included leadership and followership techniques, values and ethics training, critical thinking skills, and military history, among other topics.

Upon induction as a T-0 (technician apprentice), Kelly moved on to the first duty station. Once there, Kelly checked into the TRED center for skill training. (Rather than traveling to a dedicated training base, Kelly could receive all skills training locally.) Kelly was introduced to the computer at the TRED center. The computer accessed all databases concerning Kelly's previous training and networked with the database for Interplanetary Defense Systems. The EXTOR synthesized all module training curricula with what it has already learned about Kelly's KSA and then tailored a training program. Kelly then became immersed in a VR holodeck to rapidly learn everything necessary to keep the Interplanetary Defense Systems operable. Kelly was then an initially qualified IDS technician and received the requisite pay raise and promotion to T-1.

One day Kelly was directed to participate in a combined exercise. Environmental limitations had for years prevented physically large military forces from actually exercising together . Since 2011, all major exercise had been conducted "virtually" with tremendous cost savings and

minimal environmental impact. Organized, planned, and executed by SimNet at Norfolk, the exercise involved several nations' military forces, as well as other organizations (United Nations, Centers for Disease Control, and Greenpeace). Prior to exercise kick off, Kelly visited the TRED center to update skills via EXTOR, which had identified new techniques since Kelly's last visit to the TRED center. Kelly's highly successful performance in the giant exercise earned Kelly a promotion to journeyman IDS technician (T-4). In addition, Kelly received a performance-based raise. Now Kelly was eligible for his next phase of military education.

On off-duty time, Kelly visited the TRED center to continue leadership and judgment education. The EXTOR provided Kelly the curricula online from the Maxwell Leadership Center of Excellence, and Kelly learned more about leadership, judgment, integrity, and military values. After completing these modules, Kelly reported to the Collaborative Leadership Laboratory (CLL) at Maxwell (7-10 days) for interpersonal bonding with peers and face-to-face leadership experiences and exercises. The Microbrewery in downtown Montgomery remains a premier site for after-hours bonding. Having completed CLL, Kelly returned to the original duty station.

A contingency arose and the folks at JPC identified Kelly from their database as possessing the appropriate KSA to participate in the operation. Notified of this assignment, Kelly reported to the TRED center, and the EXTOR shuttled off to the curriculum banks to retrieve courses on asteroid composition, trajectory physics, and language training—courses which Kelly completed before connecting with the rest of the ad hoc team through the holodeck to rehearse the entire scenario. If necessary, Kelly could have deployed with the rest of the specially selected team to fulfill specific military objectives.

Throughout a 20-year career, Kelly continued to learn and advance. Learning opportunities were always available and most military members took advantage of them to increase their rank, pay, and responsibilities.

Chapter 5

Recommendations

Technologies coming of age in the first quarter of the twenty-first century should make agile TRED possible. Several of the technologies inherent in the ET2025 architecture likely will be available well before 2025.[1] Nonetheless, it may be 2025 before these ideas and capabilities warrant the confidence necessary to allow their implementation on a global scale. For example, there will be great reluctance to allow automated, interactive courseware and expert training aids to replace the direct personal interactions upon which we traditionally rely for instruction, evaluation, and validation. Therefore, these concepts must undergo a significant validation process (10 years?) to prove their efficacy.

The armed forces must conduct validation testing of several major areas prior to embracing these capabilities to build the brilliant force. The services are currently developing learning ability measurement programs, advanced selection tools, and other personnel testing programs that will be available prior to 2025. However, prior to employing these technologies in Brilliant Force applications, the military must conduct significant validation testing in parallel with more traditional force maintenance tools to verify, validate, and build high levels of confidence in their performance predictive abilities. On a parallel note, the military must validate the performance of automated, interactive, and distance learning technologies by conducting a scientific analysis

comparing their performance with more traditional teaching methods. It is entirely possible the technology advocated to build the Brilliant Force architecture will not prove feasible for all types of TRED requirements. This analysis and testing period must illuminate which TRED opportunities demonstrate the greatest payback for applying future learning technologies to particular situations.

Agile TRED can become a reality for the air and space services of the future if we invest in the right technologies and discard the pipeline paradigm for TRED. Concurrent with revamping our TRED structures, we may also need to change our compensation (rank/pay) structures. Tom Broersma, a consultant specializing in developing high-performance learning organizations, suggests twenty-first century organizations, including government agencies, will operate more effectively if people are paid based on their knowledge and skills, rather than longevity. He further suggests that teams should evaluate their members based on performance, and then use performance to determine promotion and salary.[2] Among other things, this scheme would establish motivation for members to acquire TRED on their own, decreasing the on-duty time required to train personnel. To Broersma, effective organizations will view the capacity to learn—both individually and as an organization--as a competitive advantage and will view training as an investment strategy.[3]

As the services consider adopting new training paradigms, they also should consider adopting new training partners. To paraphrase Alphonso Hall, agile education requires an enterprise-wide view that takes advantage of forming alliances with other organizations to fulfill mutual goals.[4] The military should consider cooperation with academia and corporate America to meet TRED requirements in 2025. Many military specialties, particularly in medicine, engineering, and the sciences, have requirements that mirror the training requirements of their counterparts in the

civilian world. Would it not make sense in a future where educated, intelligent people will be at a premium, to encourage cooperation, rather than competition, with the corporate world?

Using the current reserve system as a point of departure, the military and the corporate world could arrive at some workable solution which would cut initial and continuing training costs for each and provide increased communication and understanding of each other's needs and goals.[5] Mutual investment in and development of agile training technologies—VR and AI--and sharing of those technologies, rather than of the human resources, might provide an alternate means of establishing cooperation with industry.[6]

Finally, it is likely that sophisticated education and training technologies and sophisticated screening tools may not prove to be cost-effective for all career fields or skills. To make the best use of these emerging technologies, the services should review their specific needs to identify mission-critical, service-unique skills and capabilities that could be well served by advancements in selection and TRED technologies. Further, the services also should work to identify those skills that could be provided through nonmilitary training, either before accession or through cooperation with industry. The concept paper, "Pre-Trained Service Personnel," also suggests this, noting the services could recruit personnel based on their educational and technical qualifications.[7]

Emerging technologies in education and training, suitably cultivated and appropriately validated, have tremendous potential to revolutionize military education and training. Advanced screening techniques, advances in artificial intelligence and artificial reality, and continuous improvements in computing and communications technology will enable a truly "agile" education and training architecture by 2025. This architecture, consisting of such elements as the national knowledge superhighway, academic centers of excellence, and expert tutors, will bring the

concepts of just-in-time learning, learning-on-demand, and tailored learning to fruition and will underpin the success of the Brilliant Force across the full spectrum of military operations.

Notes

[1] Several other concepts submitted to the 2025 study detail technologies or ideas already accessible; they could be implemented in 1996 if anyone chose to do so. Thus, the following concepts are not included in this 2025 white paper: 900174, 900327, 900644, 900247, 900171, 900349, 900119, 900226, 900631.

[2] Tom Broersma, "In Search of the Future," *Training and Development*, January 1995, 39.

[3] Ibid.

[4] Moskal, 14.

[5] Kimball and Young, "Educational Resource Sharing and Collaborative Training in Family Practice and Internal Medicine," *Journal of the American Medical Association*, 25 January 1995, 320.

[6] 2025 concepts, no. 900174, "Contracted Support Infrastructure" and no. 900247, "Enhanced Total Force," 2025 concepts database (Maxwell AFB, Ala.: Air War College/***2025***, 1996). These concepts tie in with this. The first one advocates contracting out most support functions and becoming a single service. The most significant drawback to this would be the nondeployability of contracted personnel during hostilities. The second concept suggests a greater use of the guard and reserve forces which might be more feasible if a comprehensive program of cooperation with industry were initiated.

[7] 2025 concept, no. 900569, "'Pre-Trained' Service Personnel," 2025 concepts database (Maxwell AFB, Ala.: Air War College/***2025***, 1996).

Appendix A

Technologies and Capabilities Summary

Table 1 lists the key Brilliant Force concepts and subsystems, and isolates each with respect to the technologies and capabilities upon which it builds. The resulting matrix visually depicts two key notions: the technologies and capabilities most critical to the development of advanced learning and TRED architectures for 2025. It also depicts those concepts and subsystems relying on the broadest spectrum of technological advancements to achieve full utility.

From this chart, we can discern that the education and training architecture envisioned for 2025 relies heavily on continuing technological advancements in three primary areas: artificial intelligence, expert/adaptive systems, and computing power. Further, it appears that the concepts requiring advancements across the broadest spectrum of technologies include the full use of enhanced screening capabilities and the development of a hyperlearning capability.

Table 1

Technologies and Capabilities

CONCEPTS & SUBSYSTEMS \ TECHNOLOGIES & CAPABILITIES	PHYSICAL/COGNITIVE TESTING	COGNITIVE MODELING	JOBS SKILLS CLASSIFICATION	PERFORMANCE PREDICTION	LONG-HAUL HIGH-BANDWIDTH COMM	ARTIFICIAL INTELLIGENCE	EXPERT/ADAPTIVE SYSTEMS	VIRTUAL REALITY/HOLOGRAPHY	ENHANCED COMPUTER PERFORMANCE
ENHANCED SCREENING	X	X	X	X		X	X	X	X
LEARNING ON DEMAND					X				X
TAILORED LEARNING		X				X	X		X
EXPERT TUTOR		X				X	X		X
NATIONAL KNOWLEDGE SUPERHIGHWAY					X				X
ACADEMIC CENTERS OF EXCELLENCE					X		X		X
HYPERLEARNING	X	X	X		X	X	X	X	X
AUTOMATED COURSEWARE DEVELOPMENT			X			X	X		X
INTERACTIVE ADAPTIVE COURSEWARE			X				X		X

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